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ABSTRACT

Three visual media--sequential still photographs, slides, and motion pictures--were investigated to discover how effectively each of the three help to convey concepts involving time, space, and motion. A total of 594 subjects were selected from an introductory independent-study course in botany and randomly assigned to one of the three presentation modes in either a timed or non-timed format. Analyses of the data from attitude scales and questionnaires which were administered upon completion of the study materials showed that for concepts involving time, mean scores in the movie condition were significantly higher than for both slides and still photographs. However, with concepts involving motion, mean scores in the movie and slide treatments were significantly higher than those in the still photograph condition. For concepts involving space no significant differences were found, although there is a suggestion that still photographs are more effective. No significant interaction between format and presentation mode was found except with concepts involving time, and this difference can be attributed to an artifact. The study demonstrates, then, that the three modes of presentation differ in their ability to convey concepts of time, space, and motion, but that there is no demonstrated superiority of any one form of media in an independent study format. (SH)

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# THE EFFECTIVENESS OF THREE VISUAL MEDIA IN TEACHING CONCEPTS INVOLVING SPECIFIC ATTRIBUTES IN INDEPENDENT AND TRADITIONAL STUDY FORMATS[1]

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New approaches to education are stressing independent study flexibility in presenting materials for learning (cf., Bloom, 1968; Postlethwait, Novak and Murray, 1969; Taber, Glaser and Schaefer, 1965). Two questions arise with respect to the use of media in this movement.

1. Within a flexible system such as an audio-tutorial systems approach where it is possible to present information via several media, are there general guidelines for selection of specific media to present specific concepts?

2. Are some media more easily adopted and adapted for use in an independent study format?

Lumsdaine (1962) contended that research in instructional media should be directed toward determining the effects of

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[1] A paper presented at the American Educational Communications and Technology convention.

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specific factors in the design or use of media rather than confined to an overall assessment (see also; Travers, et. al., 1967; Travers, 1966). After studying the effects of using specific media for different concepts, it should be possible to determine which media and conditions for use are most effective in the presentation of specific concepts. With this knowledge, curriculum designers could select the most effective medium to teach each specific concept (Roshal, 1960; and Van Mondfrans and Houser, 1970).

In a paradigm for selecting media to present basic concepts, Van Mondfrans and Houser (1970) outline several important steps in the selection process. They suggest that the concepts to be presented be described in terms of their defining attributes. The next step is to specify the stimulus dimensions along which these attributes occur (for example, the attribute "round," one of the defining attributes of a "ball," occurs along the stimulus dimension "shape"). Next the media available should be examined to determine which stimulus characteristics they can present. The paradigm then suggests that the stimulus dimensions required by the nature of the defining attributes of the concept determine which available medium should be used. The appropriate medium would be the one which could present all of the stimulus dimensions required.

For example, examine the stimulus dimensions required to display the defining attributes of a biological concept like nutation, the

slight circular movement in the stem of a plant caused by irregular growth rates of different parts. It is evident that extension in time is one defining attribute of this process concept and the medium chosen must present temporal relationships.

When more than one medium has the capability of presenting all relevant stimulus dimensions, choosing which to use can be done on the basis of cost and usability or on the basis of more specific information concerning the interactions of media and type of concept. Within the general framework of the paradigm briefly described above, the present study was conducted to generate information about the effects on learning of presenting visual concepts via different visual media.

The visual concepts used involve the manipulation of time, space and motion; the three visual media were sequential still photographs, slides, and motion pictures. The investigation was to discover how effectively these three visual media help to convey concepts involving the dimensions of time, space, and motion.

## METHODS

Inasmuch as the testing program was conducted in a general biology class, experimental materials were based on the attributes of time, space and motion demonstrated by biological phenomena. Time lapse (acceleration), slow motion (deceleration), and unequal time periods can all be demonstrated with appropriate biological exemplars,

as can the enlargement and diminishment of space. Random motion and acceleration - deceleration of motion are also inherent in biological processes.

The deceleration of time, for example, was demonstrated with slow motion pictures of the dehiscence of Balsam Capsules, the explosive release of seeds as the ripe capsules split open. Enlargement of space was illustrated by photomicroscropy of sequential sections through a corn fruit, and the acceleration - deceleration of motion was demonstrated with photographs of the movements of chromosomes during the anaphase of endosperm mitosis-the stage in which the daughter chromosomes move toward the poles of the nuclear spindle prior to cell division.

Each visual medium used-silent motion pictures, sequential slides, and sequential still photographs-has advantages and disadvantages for conveying concepts of time, space, and motion. The continuous nature of silent motion pictures creates the illusion of motion occurring over a period of time. Changing the lens focal length or distance-to-subject allows variation in space-the area photographed can be large or small. Zoom lenses, too, permit continuous changing of area over a period of time. However, motion pictures require sophisticated equipment, are costly to develop, maintain and replace, and in general, films burden time and budgets. They are also inflexible in that students must view them where and

projection equipment is available. Review may be out of the question.

Since slides are projected still pictures, they are intermediary between motion pictures and printed sequential still photographs. For this experiment, subject matter experts selected the number of frames from each motion picture sequence necessary to transmit the vital visual information. These were then developed as slides. Viewing the slides exposed the subjects to a series of interrupted events projected in a static location. From these they were to determine for each concept how time, space or motion was manipulated.

Although portable slide viewers are much more available than motion picture projectors, to make the medium accessible to individuals would require the preparation of multiple slide sets, a project whose cost would be prohibitive. Therefore, the same shortcomings of cost and flexibility noted for motion pictures are applicable to slides.

Sequential still photographs, an arrangement of individual motion pictures frames in printed format, transmit visual information by their grouping and size as well as content. The passing of time can be indicated by including a clock in the scene, arranging the pictures to simulate the face of a clock, or both. Acceleration can be indicated by regulating intervals between frames, while incorporating in the visual content a reference point and clock to determine distance

travelled per unit of time. Area can be expressed through content or size.

All three presentation modes were developed from the motion picture stock to insure that all subjects would view materials containing identical information.

Subjects were selected from those enrolled in an introduction to Botany course taught in the audio-tutorial systems format at a large midwestern university. Students were randomly assigned to one of six groups and the groups were randomly assigned to one of the three presentation modes in either a timed or non-timed format. In the timed format, students were instructed to view the visual materials only once without stopping the projector, without interfering with the automatically timed slide changer, or without reviewing any of the still photograph sequences in the printed booklet. In the non-timed format, students were told to control both the movie and slide projectors as they desired; they could reverse them to review any previous part and thus determine the rate of presentation. They could also study the printed booklet of sequential stills as they pleased.

Each group of subjects viewed the biological phenomena involving the concepts of time, space, or motion by a different presentation mode. Early in the semester they viewed the materials concerned with space, later in the semester the material concerned with motion, and last the material concerned with time. The number of subjects for these three programs was respectively 204, 210, and 180.

Tests consisting of fifteen objective questions and attitude scales were administered immediately upon the students completion of the experimental study materials. These evaluation instruments were reviewed by a panel of experts while the visual materials were still available. No previous biological background was necessary to score well on the tests. All information included in the questions was covered in the visual materials.

The data from the tests were analyzed in a 3 x 2 factorial analysis of variance. The main effects were mode of presentation (motion pictures, slides, and sequential still photographs) and study format (timed and non-timed). The data from each of the three tests were analyzed separately and also combined for an analysis of the overall effectiveness of the three media. The level of significance was set at .05. When a significant F ratio was found for the presentation mode factor, a Newman-Keuls sequential range test (Winer, 1962) was calculated to compare pairs of means.

## RESULTS

### Concepts involving time.

The analysis of test scores for this program showed a significant F-ratio for the presentation mode factor ($F_{(2,174)} = 3.70$, $p < .05$). Application of the Newman-Keuls test showed that the mean score for movies ($\bar{x} = 8.52$) was significantly higher than for both sequential slides ($\bar{x} = 7.67$) and sequential still photographs ($\bar{x} = 7.47$). The latter two treat-

ments were not significantly different.[3] The F-ratios for the study format factor and the interaction of presentation mode and study format were not significant.

When the time spent in studying the materials was used as data, significant F-ratios were found for the presentation mode factor ( $F_{(2,174)} = 11.62$, $p < .05$) and the interaction of the study format and presentation mode factors ( $F_{(2,174)} = 26.59$, $p < .05$ ). The mean time for the study of slides ( $\bar{x} = 13.9$ ) was significantly greater than for movies ( $\bar{x} = 12.2$ ) and sequential still photographs ( $\bar{x} = 10.5$ ) and the mean time for the study of the movies was significantly greater than that for sequential still photographs, ($p < .05$). Movies under the non-timed study format ( $\bar{x} = 14.57$ ) and slides under the timed format ( $\bar{x} = 16.47$ ) took significantly longer than the other four combinations of these two factors. The slides under a timed format also took longer than the movies under the non-timed format.

Concepts involving motion.

The F-ratio for presentation mode was significant ( $F_{(2,204)} = 3.64$, $p < .05$ ) when the data were test scores for the concepts involving motion. The mean test scores for subjects

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[3]Complete tables of means and ANOVA and Newman-Keuls summary table are available from the first author upon request.

in the motion picture ( $\bar{x}$ = 11.61 ) and slide treatments ( $\bar{x}$ = 11.47 ) were higher than in the sequential still photograph treatment ( $\bar{x}$ = 10.67 ). The motion picture and slide treatments, however, did not differ significantly.

F-ratios for the study time data did not reach significance.

Concepts involving space.

None of the F-ratios for the data from concepts involving space were significant. The F-ratio for presentation mode did approach significance ( $F_{(2,198)} = 2.95$, $F = 3.05$ needed at the .05 level). A visual inspection of the means suggests that sequential still photographs ( $\bar{x}$ = 9.72 ) and slides ( $\bar{x}$ = 9.88 ) are more effective in presenting concepts involving space than motion pictures ( $\bar{x}$ = 8.88 ).

When the test scores for all three types of concepts were pooled, no significant differences were found.

## DISCUSSION

That motion pictures, slides, and sequential still photographs differ in their ability to convey concepts of time, space, and motion is demonstrated by this study. For example, in order to perceive time, one must perceive events occuring through a period of time. A still picture is merely a static representation of an instantaneous event, while motion pictures can depict continuity, an attribute of passing time. In the program for concepts involving

time, the test score mean was higher for students who viewed motion pictures than for those students viewing static pictorial displays. While it is possible that this finding is a result of the particular slides and sequential still photographs used (either the number used to depict each concept involving time or some other peculiarity), it appears that concepts involving time are best presented with a medium which allows a continuous presentation (as perceived by the audience). Further testing could be executed using other media such as tape recordings (video and audio) that also have the capability of continuous presentation.

The length of time required to complete the study program for concepts involving time varied greatly. Sequential still photographs required the least amount of study time under both the timed and non-timed format. When comparing the time spent with slides presented under the timed format, movies under the non-timed format, and sequential still photographs, the difference is significant. However, the requirements of the equipment and procedures involved probably account for most of the difference. In addition, since analyses of time spent studying in the other programs did not yield significant differences, it cannot be said that one medium has an advantage over the others.

Perception of motion, like perception of time, requires perception of a series of continuous events. The ability to

detect motion requires a point of reference. A static instantaneous representation, such as a single slide or photograph, does not directly transmit information concerning the direction or speed of motion. For this study, however, it was hoped that the number of slides and photographs would be enough to insure the points of reference necessary to determine the speed and direction of motion. Since in the movies the rate of presentation of individual frames insured the perception of continuous motion, the movie treatment was found to be more effective than sequential still photographs in presenting concepts involving motion. What was quite unexpected, however, was that slides were also more effective than sequential still photographs, while there was no significant difference between the effectiveness of motion pictures and slides. One possible explanation may be that in the case of sequential still photographs, the subject was required to move his eyes across the page, constantly changing his reference point. When viewing slides, the subject focussed his eyes on one point while the slides changed, making the object's change of position in each succeeding slide more apparent. If the sequential still photographs had been presented in a flip-book format (like some comics of old) so that each succeeding image replaced the one which preceded it, a similar result might have been obtained.

The F-ratio for presentation mode approached significance for concepts involving space. The mean scores for the treatment groups suggested that slides and sequential still photographs were more effective for presenting concepts involving space than motion pictures. All four means for static picture representations were higher than the two means for the motion picture groups.

One reason for this result may be that space as involved in the concepts used in this experiment remained constant. Another may be that where the aspects of space itself were of primary importance motion was distracting. It is therefore reasonable to consider static presentations more effective than motion presentations in presenting concepts involving space.

The results of this study suggest that certain visual media are more effective than others in presenting concepts involving time, motion, or space. Of the three visual media used, motion pictures were more effective for presenting concepts involving time; motion pictures and slides were equally effective for presenting concepts involving motion; and sequential still photographs and slides appeared more effective than motion pictures in presenting concepts involving space. These findings support the important features of the media selection paradigm suggested by Van Mondfrans and Houser (1970), but further investigation is

needed to isolate more clearly the specific factors influencing results. The tentative explanations offered above suggest several areas that need further investigation.

The second question raised in this study concerning whether certain media are better fitted for use in an independent study format is answered by the fact that analysis of the data revealed no significant interaction between study format (Timed-non-timed) and mode (movie, slide, stills). The one exception was the mode-format interaction for the time spent during the study program which included concepts involving time. The length of time required to present the slides in the timed format was fixed by the five second timing of the projector. And much of the extra time required for the non-timed movie presentation can be accounted for by the time consumed operating the projector for review. Thus the significantly greater length of time required for these two combinations of mode and factor can be attributed to an artifact. There is no demonstrated superiority for any one form of media in an independent study format.

As to general effectiveness in the visual presentation of concepts involving time, motion and space, it should be noted that when the test scores for all three concepts were pooled, no significant differences were found among the three presentation modes.

If media decisions at a specific level based on what is required to display the defining attributes of a concept are not possible, then decisions at a general level should be made on a basis other than pedagogical effectiveness. Perhaps matters of availability, permanence, portability, inexpensiveness, etc., are more important.

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